

REMARKS

This response follows an Action of August 8, 2001 rejecting claims 1-8. The petition and fee associated with a one month extension of time are attached herewith.

The Applicant notes with the appreciation that the Examiner has acknowledged receipt of the priority document under 35 U.S.C. § 119.

Claims 9-13 have been cancelled. The Applicant reserves the right to file a divisional application on that non-elected specie.

The Applicant is attaching herewith an Information Disclosure Statement setting forth the materials that have been referenced in the specification as well as other materials for consideration by the Examiner. The Applicant has amended the claims, to be discussed herein, and based on those amendments and the remarks that follow request reexamination and reconsideration of all rejections and objections set forth in the Office Action.

With respect to paragraph 2, the Applicant has listed the two references cited in the specification as a part of an Information Disclosure Statement. But the Applicant traverses the Examiner's holding that it is improper to incorporate the subject matter by reference because in the Examiner's view "both articles are not enabling to the particular claimed invention". First, the Applicant respectfully points out that the issue of enablement, from the prospective of one of ordinary skill is based on the subject matter as a whole. Thus, it is entirely proper for the Applicant to rely for purposes of enablement on showing within the art one component of the claimed combination. There is no necessity that the material incorporated by reference enable the claimed invention as a whole. Rather, it is entirely proper for the Applicant to point out where a particular structure is enabled within the art, incorporate that disclosure by reference and

then demonstrate that the specification as a whole is enabling for the claims. It is on that basis that the articles Reboux and Borowski are entirely proper relative to issue of enablement.

The Applicant will turn to that point, the rejection in paragraph 4 of the Office Action. The Examiner first contends that the nuclear core 8 and the heat engine 19 shown grammatically in Fig. 1 are not enabled because they are used to rotate all of the propellant pumps 10, 14 and 16 and the electricity generator 11. The Examiner considers the Borowski article as not enabling nuclear-core/engine combination. The holding is respectfully traversed on this point.

As a precursor, as noted the issue of enablement is from the perspective of one of the ordinary skill and certainly there can be no debate that broadly the use of a nuclear core and heat engine is conventionally used in nuclear power plants. In that application, the nuclear core produces steam which in turn is used to rotate a heat engine which then in turn rotates a generator for purposes of producing electricity. That broad use of a nuclear core as a heat source is of course well known and no citation is required. Moreover, by way of reference the Examiner could easily have taken notice of the fact that many heat sources or a steam engine has been known for more than a century to produce mechanical energy. The specificity of the nuclear plant, by a nuclear core as a replacement for a more conventional mechanism, such as one producing steam or gas to produce heat certainly cannot by itself raise an issue of enablement.

In this invention, mechanical energy is produced by heat engine which is used for the purposes of rotating the electricity generator. A marginal amount of the mechanical power is also used for the pump. Certainly, one of ordinary skill would have no difficulty enabling that broad concept in the context of this invention.

Borowski discloses a particle bed reactor (40 MW/l; 0.30.5 MW/kg). This is distinguished from a conventional reactor because it has a more efficient cooling cycle that is obtained due to a large heat transfer area of the particles. Reference is made to page 36, column 2 and page 37, column 1. The result then is that the specific mass will be lower than that of a conventional nuclear reactor. Borowski is cited as a recommended embodiment for the nuclear core per se. The particle bed reactor taught by the reference is a source of heat or steam which then can be used by heat energy to produce mechanical energy as indicated. It is believed thus for the particular application and citation of the reference such is entirely proper to support enablement of the invention as a whole.

The same exist relative to a Brayton cycle. The Examiner holds that the disclosures set forth by the Applicant on page 15 line 5 relative to the pressure ratio of 82.2 and the factor 0.2 on page 17, line 15, that is the denominator of the formula are insufficient and not enabling. This holding is respectfully traversed. First, the ratio $r=88.2$ on page 15, line 15 is given by a formula as a function of temperature, that is $T_3 = 200K$ and $T_1 = 60K$. The temperatures are explained in the specification on page 14, lines 8-10.

The temperature T_3 at $200K$ is a temperature at which the fluid is heated by the heat exchanger and noted as element 65 which is disposed in the nuclear reaction. The same definition of T_3 is found on page 19, lines 13-15.

The temperature T_1 , at $60K$ designates a temperature of the fluid such as helium at the inlet to the compressor, as element 43. The Examiner should note this consistent definition of T_1 on page 18, lines 8-9.

The Brayton cycle is well known. Attached for a reference is a portion of a text of thermodynamics, "A Macroscopic-Microscopic Treatment", Lay (Pitman & Sons, Ltd. 1963). Reference is made to pages 565-572. Reference is also made to chapter 19-13 dealing specifically with "the Brayton Cycle" and to section 19-14 "Brayton Cycle with Regeneration and Stage Compression". Lest there be any doubt, the Applicant also submits a publication by Ashe, "Closed Brayton Power Conversion System Design and Operational Flexibility". Note pages 884-893, that is the context of this article which describes generally the use of Brayton Cycle power conversion for this specific application here namely space power applications.

Finally, with respect to the Examiner's holding of nonenablement, the ratio 0.2 set forth on page 17 line 15, that is the denominator of the formula corresponds to the implementation of the nuclear reactor. This is 0.2 MW/kg set forth on page 12 lines 33-36. Such is less efficient than the particle bed reactor according to Borowski on page 37 at column 1 that is 0.3 MW/kg to 0.5 MW/kg. The purpose is to provide an estimate of governing weight. As such, the Examiner's specific criticisms on the issue of enablement are respectfully traversed and reexamination is requested.

Dealing with other non-prior art issues, the Examiner also holds that the article Reboux is also not enabling. Again, the purpose of this reference was not to enable the claim combination as a whole but rather to provide support, within the literature that an optimum frequency exists at which the number of turns constituting an energy transfer loop can be minimized. This frequency is a function of the diameter of the nozzle and is about 60KHz for a diameter of approximately 0.7 m. Thus, the reference provides support to allow the artisan to have the invention as whole clearly enabled.

In paragraph 6 the Examiner contends that the disclosure contains informalities on page 9, lines 25-26 with respect to the frequencies as not existing with those on page 13, line 30. Clearly, however a speed of rotation of 30,000 rpm, *i.e.*, 500Hz will lead to the direct production of electricity at 60KHz. Clearly, the device in question is an alternator, well known and not requiring additional description. The reason why the frequency obtained is several orders of magnitude of KHz greater than that of the operating frequency is because the mere speed of rotation of an alternator provides only one parameter, it being known that an alternator has a large number of poles on the stator. As a result, the direct use of an alternator at a given rotational speed will produce electrical energy at a different frequency at a rotational speed of the device itself.

With respect to the holding in paragraph 5, the Applicant has amended claim 1 to provide an antecedent basis for limitations in that claim. The Applicant has also reviewed the remaining claims and has made additional changes to provide on an antecedent basis for the limitations set forth in those dependent claims. Thus, the rejection under 35 U.S.C. § 112 second paragraph should now be removed.

Turning next to the rejections predicated on prior art claims 1 and 2 stand rejected as anticipated by Dailey '623. This rejection is respectfully traversed. The Examiner cites the reference for disclosing broadly a propulsive device 10 having a chamber 12, a nozzle and an inductive loop 16 to heat ejected gases. The inductive loops are connected to a high frequency generator, illustrated in Fig. 3 and a divergent section positioned downstream the loop.

Dailey is prior art acknowledged by the Applicant. Reference is made to page 4 beginning at line 25. Dailey, in that class of prior art utilize a magneto-plasma-dynamic (MPD)

technique which is distinguished from this invention. That technique consists of placing inductive loops for the purpose of accelerating electrons or ions present in the outlet flow. The purpose is not heating the ejected gases as the Examiner contends is an inherent function of the loops. Rather, and more properly the loop is used for the purpose of accelerating electrons or ions.

Reference is made to page 5 lines 16-25 and Applicant's claim which describes other differences between Dailey and this invention. Dailey for example in column 2 line 33-45 properly describes in his device employs a Lorentz force. This is a magnetic accelerating force which is proportional to the product of $j \times B$ where j is the current and B is a magnetic field. The result then is that Dailey employs MPD.

Dailey also clearly indicates, for example on page 2 line 47 that the result is to create a net propulsive force for a specific variation with time of the field. This is a specific current waveform illustrated by the patent in Fig. 3. Reference is made to page 2 line 56 for the importance of that waveform. Additionally, Dailey indicates that the invention described there would provide no net thrust if a symmetrical waveform were used. Thus, a sinusoidal current which is applied to the induction heating coil defined here would have no effect in Dailey. The fundamental difference in both concept and structure is thus manifest. Dailey requires specific electrical circuitry to produce a damp sinusoidal signal having a specific desired shaped. In contrast, the Applicant's system generates electrical power as a pure sinusoidal form. There is no need for any transformation into a different waveform. The electrical power here includes sinusoidal current in the exhaust gas for which the only effect sought is heating, that is to raise the temperature of the gas. The Examiner can appreciate that the transformation of electrical

power into heat by induction is a straight forward mechanism. The transformation of heat into thrust is obtained by the nozzle extension downstream on coil. This is illustrated by reference 7. Dailey has no use for that nozzle extension.

Moreover, the transfer of electric energy by heating is advantageous when compared to that of Dailey. Applicants invention allows for the use of high amounts of power to be transformed with minimal loss. This is especially true if the electrical circuitry is rendered superconductive. At this level of power the thermodynamic efficiency of different portions of the system is critical because even a small percentage of the power dissipated at the wrong location raises, for example safety concerns. Thus, it is believed that the rejection predicated on anticipation is erroneous and should be revisited.

The Applicant also respectfully traverses the rejections in paragraphs 10 and 11 with respect to claims 3-5. Oberly '200 does not compensate for the deficiencies in Dailey. Oberly is directed to the design of a high-voltage and high-powered generator which uses cooling by liquid hydrogen. It however is not directed whatsoever to the management of electric losses in the context of rocket propulsion.

It is known for example that hydrogen is one of the best propellants used for rocket propulsion due to its low molar mass. It is typically stored in liquid form to limit tank volume and pressure. Hydrogen thus is extremely cold and requires a large heat sink. Oberly contains no recognition of the use of hydrogen in the context of a propellant.

In that regard it is known that using liquid hydrogen as a propellant requires heating the hydrogen to high temperatures. Any contribution to this heating results in a contribution to the overall thrust of the propulsion system. Thus, if the liquid hydrogen is used first, to cool an

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electric generator there is a waste of heat resulting from the efficiency of the generator is lower than one which would not be wasted that contributes overall to the increase in propulsion. Oberly is concerned with issue of minimizing losses in an electrical generator and not a contribution to thrust.

More realistically the reference would be considered non-analogous technology to this invention.

Finally, while the Examiner applies Oberly to claim 5, that claim is directed to the injection chamber having endless free first and second propellant fluid of the propulsion device. In Oberly, elements 40 and 52 of the tanks are used to feed LH₂ and LOX to the turbo-alternator electricity generator and not used in any manner as a propulsive media. This again points out the non-analogous nature of that reference.

The Applicant thus respectfully points out that based on reexamination and reconsideration of this application the claims here should be considered allowable. Should the Examiner wish to discuss the application the Applicant stands ready to discuss it with the Examiner at his convenience.

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Applicant hereby petitions for any extension of time which may be required to maintain the pendency of this case, and any required fee, except for the Issue Fee, for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 9-13 are canceled.

The claims are amended as follows:

1. (Amended) The propulsion device comprising; an injection chamber for at least one propellant fluid, [which] said injection chamber [is] disposed upstream from a gas injection nozzle, [the device having] an induction loop surrounding a zone of the nozzle to heat [the] ejected gases, and [having] a high frequency electricity generator for powering said induction loop.
2. (Amended) A device according to claim 1, wherein the gas injection nozzle has a diverging region disposed downstream from the induction loop.
3. (Amended) A device according to claim 1, further comprising a heat exchanger and wherein at least one of said propellant fluids receives heat upstream from being injected into said injection chamber from [a] said heat exchanger for cooling the nozzle and/or the injection chamber.
4. (Amended) A device according to claim 1, further comprising at least a first heat exchanger and wherein at least one of said propellant fluids feeds said at least a first heat exchanger for cooling the electricity generator.

6. (Amended) A device according to claim 5, [having] further comprising a nuclear core which constitutes a heat source for a heat engine which is coupled to the electricity generator and at least a second heat exchanger and wherein at least one of said propellant fluids is supplied in cryogenic form and passes through said at least a second heat exchanger to constitute a heat sink for the heat engine.

7. (Amended) A device according to claim 6, further comprising at least a third heat exchanger, and wherein at least one of said propellant fluids feeds through said at least a third heat exchanger which is heated by said nuclear core and which is disposed downstream from said second heat exchanger.

8. (Amended) A device according to claim 6, [wherein the heat engine drives] further comprising at least one pump for circulating and pressurizing at least one of said propellant fluids, said pump driven by said heat engine.